

PROJECT facts

Sequestration

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U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY



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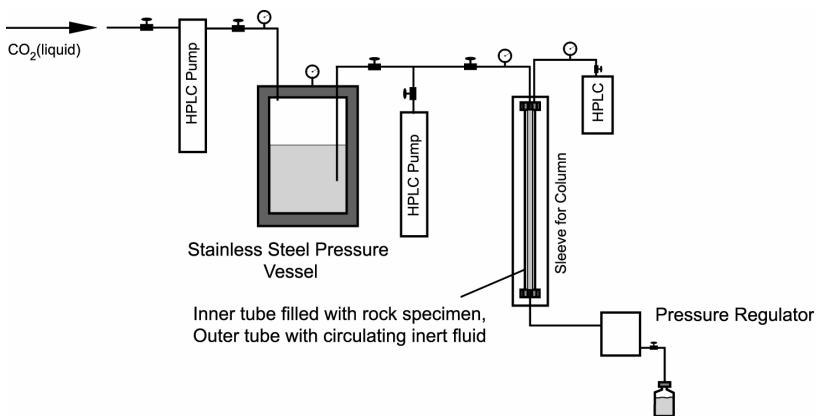
NEUTRALIZING CARBONIC ACID IN DEEP CARBONATE STRATA BELOW THE NORTH ATLANTIC

Background

The Eastern Seaboard is the most densely populated region in the country and generates a large fraction of all U.S. anthropogenic CO₂ emissions. Disposal options for the large volume of CO₂ produced in this region are limited. Land transport and disposal are difficult due to high population density. From geographical considerations, offshore disposal might seem a reasonable approach. However, a number of technical uncertainties and environmental concerns make it difficult to implement this option. Thus, developing technology that would allow long-term storage of CO₂ in geological reservoirs below the ocean floor would be a major breakthrough for CO₂ sequestration efforts.

The Atlantic ocean is the site of most of the world's deep sea carbonate deposition, with a wide range of sediment compositions ranging from almost pure limestone to marly shales and claystones occurring at a wide range of water depths. A number of potential disposal sites are within 200 miles of the U.S. coastline. Thus, it is essential to the carbon sequestration program to evaluate the suitability of CO₂ storage in deep-sea carbonate sediments as part of an overall strategy of carbon storage and management.

The major advantage of CO₂ injection into carbonate sediments beneath the sea floor is the natural chemical buffer created by the reaction between calcium carbonate and carbonic acid, producing high-alkalinity pore fluid. Unfortunately, the reaction kinetics of CO₂/water mixtures with natural carbonate sediments consisting primarily of microfossils is not well determined at the pressures and temperatures of interest.



Schematic drawing of the experimental system



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WEBSITE

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PARTNERS

Harvard University
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U.C. Santa Cruz

COST

Total Project Value
\$801,374

DOE/Non-DOE Share
\$801,374/\$0

The technical issues of injection are relatively straightforward, although some questions do exist. Drilling into carbonate sediments is relatively easy. At shallow depth below the ocean floor these deposits have high porosity but very little structural integrity. At deeper levels, they have lower porosity and would allow little flow. However, oil extraction from such fields shows that hydrofracturing is a viable option. Also, after a relatively short period of injection, dissolution of carbonate material could provide greatly increased permeability. The calcium carbonate present will be consumed in neutralizing carbonic acid and leave behind an increased pore volume filled with calcium bicarbonate solution.

Thus, disposal by injection into carbonate sediments below the sea floor could provide an extremely large sink for CO₂; the CO₂ would be neutralized in a chemical reaction that turns solid calcium carbonate into dissolved bicarbonate. The physical characteristics of the reservoir would provide a series of barriers to the escape of the CO₂. If the bicarbonate-rich pore fluid did mix with seawater, then the ocean would provide an additional safeguard. Effects on the atmosphere, even on the time scale of millennia, would be extremely small, and the process should qualify as a near-permanent sequestration method.

Primary Project Goal

The primary goal is to investigate the feasibility of carbon dioxide disposal by injection and neutralization below the ocean floor in calcium carbonate sediments.

Objectives

- To understand the mechanical and chemical behavior of CO₂ and CO₂/water mixtures injected into carbonate sediments of various compositions under a range of pressures and temperatures.
- To investigate the kinetics of calcium carbonate dissolution in the presence of CO₂/water.
- To investigate the possibility of CO₂ hydrate formation in the pore fluid.
- To conduct an economic analysis to estimate costs of drilling, gas injection, and site monitoring.

Accomplishments

New project.

Benefits

There is growing concern that anthropogenic CO₂ emissions are contributing to global climate change. To mitigate this problem, it may become necessary to sequester CO₂. However, although the East Coast of the U.S. generates a large volume of CO₂, sequestration sites are somewhat limited. An obvious sink is the Atlantic Ocean, but technical and environmental concerns for most ocean sequestration options make their implementation difficult. An option that appears to avoid most concerns is to inject CO₂ into ocean carbonate sediments. The CO₂ would react to form bicarbonate ions which should be permanently trapped. Even if they should slowly migrate to ocean waters, their impact on the ocean should be minimal. Thus, this project is exploring an option that could be very beneficial in meeting our goal of reducing CO₂ intensity by 18% by 2012.